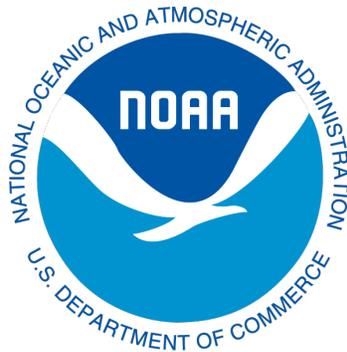


2023 Annual Deployment Plan for Observers and Electronic Monitoring in the Groundfish and Halibut Fisheries off Alaska

December 2022



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Fisheries Monitoring and Analysis Division, Alaska Fisheries Science Center
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, WA 98115

National Marine Fisheries Service, Alaska Regional Office
P.O. Box 21668
709 W. 9th Street
Juneau, Alaska 99802

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Executive Summary

This Annual Deployment Plan (ADP) describes how the National Marine Fisheries Service (NMFS) intends to assign at-sea and shoreside fishery observers and electronic monitoring (EM) to vessels and processing plants engaged in halibut and groundfish fishing operations in the North Pacific during the calendar year 2023. The ADP outlines the science-driven method for deployment of observers and EM systems to support statistically reliable data collection.

The North Pacific Observer Program is the largest observer program in the country and is responsible for monitoring a fleet of nearly a thousand vessels that fish a combination of hook-and-line, pot, and trawl gear across the Alaska Exclusive Economic Zone (EEZ) area of roughly 3.77 M km². Fishing activities are classed as belonging to either partial or full coverage components. In the full coverage component of the program, every trip is monitored by 1 or 2 observers and the vast majority of groundfish harvest is covered by this portion of the program. In 2023, NMFS expects to monitor 2,520 trips, consisting of an estimated 14,586 days, in the full coverage component of the program, and 1,090 trips and 5,355 days in the partial coverage component. The ADP mainly focuses on the partial coverage component of the program and specifies the scientific deployment design and selection rate—the portion of trips that are sampled by observers and EM.

At-sea Deployment Design

The deployment design for the partial coverage component of the program involves three elements: 1) the selection method to accomplish random sampling; 2) division of the population of partial coverage trips into selection pools or strata; and 3) the allocation of deployment among strata.

Selection method:

- In 2023, observers and EM will be deployed using the trip selection model in all ports throughout Alaska. Trip-selection refers to the method of selecting fishing trips as the sampling unit. Trip selection is facilitated through vessel operators and owners logging their trips into the Observer Deploy and Declare System (ODDS) and being notified if the trip is selected for coverage.

Selection pools:

- *Observer trip-selection pool:*
 - In 2023, there will be 3 sampling strata for the deployment of observers:
 - Hook-and-line vessels greater than or equal to 40 ft LOA,
 - Pot vessels greater than or equal to 40 ft LOA, and
 - Trawl vessels making a trip not covered by the Trawl EM pool (see below).
- *Fixed Gear EM trip-selection pool:*
 - This pool in 2023 will consist of 179 vessels approved by NMFS. This includes 9 new vessels that requested to be added to this pool for 2023 and all were approved by NMFS.
 - Prior to fishing, all the vessels in this pool are required to submit and follow a NMFS-approved VMP.
- *Trawl EM trip-selection pool:* This pool is composed of all vessels fishing under an Exempted Fishing Permit (EFP) to evaluate the efficacy of EM on pollock catcher vessels using pelagic trawl gear. The goal of the EFP is to use EM for compliance monitoring of catch under maximized retention definitions. Catch accounting for the vessel's catch and bycatch is done via eLandings reports and shoreside plant observers. Industry received National Fish and Wildlife

Foundation (NFWF) funding to support the project that includes catcher vessels, tender vessels, and shoreside processors. In 2023, 79 vessels are expected to participate in this pool.

- *No-selection pool*: This pool will be composed of fixed-gear vessels less than 40 ft LOA and vessels fishing with jig gear, which includes handline, jig, troll, and dinglebar troll gear.

Allocation Strategy:

In 2023, NMFS will implement an observer deployment allocation strategy of an adjusted 15% baseline, plus optimization based on discarded groundfish, Pacific halibut prohibited species catch (PSC), and Chinook PSC. The approach provides a balance between minimizing the variability of discard estimates, prioritization of PSC-limited fisheries, and the need to reduce gaps in observer coverage in the partial coverage category.

Dockside Monitoring

Observers will continue to collect genetic samples from salmon caught as bycatch in groundfish fisheries to support efforts to identify stock of origin. Dockside monitoring by observers occurs in the pollock fishery to enable complete enumeration of salmon and Pacific halibut bycatch and to conduct biological sampling from salmon and other species. For all trips in the Bering Sea Aleutian Islands (BSAI) trawl pollock fishery regardless of selection pool, a census of salmon will be completed during the offload. Offload monitoring for salmon, halibut, and biological data collections will also take place for vessels in the Trawl EM pool that deliver to either a tender or a shoreside processor. In the BSAI, all offloads from Trawl EM trips are to be sampled for salmon, halibut, and biological data. In the Gulf of Alaska (GOA), Trawl EM offloads will be randomly selected for sampling by observers in shoreside processing facilities.

For vessels that do not participate in the Trawl EM pool and deliver to shoreside processors in the GOA pollock fishery, trips that are randomly selected for at-sea observer coverage will be completely monitored for Chinook salmon bycatch by the vessel observer during offload of the catch at the shoreside processing facility.

Partial Coverage Selection Rates

The 2023 budget for EM and observer deployment in the partial coverage component of the program 2023 is \$5.9M, which can maintain the fixed-gear EM program and funds at-sea monitoring by observers through 2025, assuming constant fishing effort.

The selection rates (rounded to the nearest whole number) for strata in 2023 are—

- No Selection – 0%
- Hook-and-line – 18%
- Pot – 17%
- Trawl vessels not participating in Trawl EM – 23%
- Fixed-Gear EM – 30%
- Trawl EM – all vessels 100% at-sea coverage with EM; plus 33% shoreside monitoring in the GOA and 100% shoreside monitoring in the BSAI.

Introduction

Purpose and Authority

This 2023 Annual Deployment Plan (ADP) describes how the National Marine Fisheries Service (NMFS) intends to assign at-sea and shoreside fishery observers and electronic monitoring (EM) to vessels and processing plants engaged in halibut and groundfish fishing operations in the North Pacific. This plan is developed under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1862), the Fishery Management Plan for Groundfish of the Bering Sea and Aleutian Islands Management Area (BSAI FMP), the Fishery Management Plan for Groundfish of the Gulf of Alaska (GOA FMP), and the Northern Pacific Halibut Act of 1982. The ADP outlines the science-driven method for deployment of observers and EM systems to support statistically reliable data collection. The ADP is a core element in implementation of section 313 of the Magnuson-Stevens Act, which authorizes the North Pacific Fishery Management Council (Council) to prepare a fishery research plan in consultation with NMFS.

The Council's role in the annual deployment plan process is described in the analysis that was developed to support the restructured observer program (NPFMC 2011) and in the preamble to the proposed rule to implement the restructured observer program (77 FR 23326). The preamble to the proposed rule notes that:

NMFS would consult with the Council each year on the deployment plan for the upcoming year. The Council would select a meeting for the annual report consultation that provides sufficient time for Council review and input to NMFS. The Council would likely need to schedule this review for its October meeting. The Council would not formally approve or disapprove the annual report, including the deployment plan, but NMFS would consult with the Council on the annual report to provide an opportunity for Council input. The final deployment plan would be developed per NMFS' discretion to meet data needs for conservation and management. (77 FR 23344 & 23345).

The ADP follows the process envisioned by the Council and NFMS when the restructured observer program was developed and implemented. As a result, both the ADP development and the evaluation of data collected by observers and EM is an ongoing process. NMFS is committed to working with the Council throughout the annual review and deployment cycle to identify improved analytical methods and ensure Council and public input is considered.

More details on the legal authority and purpose of the ADP are found in the Final Rule for Amendment 86 to the BSAI FMP and Amendment 76 to the GOA FMP (77 FR 70062, November 21, 2012). Further details on the integration of EM deployment into the ADP process are found in the final rule to integrate EM into the Observer Program (82 FR 36991).

North Pacific Groundfish and Halibut Observer Program

NMFS implements the Council's fishery research plan through the North Pacific Groundfish and Halibut Observer Program (Observer Program). The Observer Program provides the regulatory framework and support infrastructure for stationing observers and Electronic Monitoring systems (EM) to collect data necessary for the conservation, management, and scientific understanding of the

commercial groundfish and Pacific halibut fisheries of the BSAI and GOA management areas. EM is broadly defined as technological tools which collect fishing data to support stock assessment and fishery management. In the North Pacific, EM is usually more specifically referencing video images and sensors to provide catch and discard information after video review.

The Observer Program is the largest observer program in the country and is responsible for monitoring a fleet of nearly a thousand vessels that fish a combination of hook-and-line, pot, and trawl gear across the Alaska Exclusive Economic Zone (EEZ) area of roughly 3.77 M km². Data collection through the Observer Program provides a reliable and verifiable method for NMFS to gain fishery discard and biological information on fish, and data concerning seabird and marine mammal interactions with fisheries. These data contribute to the best available scientific information used to manage the fisheries in the North Pacific. Observers and EM systems provide fishery-dependent information that is used to estimate total catch and interactions with protected species. Managers use these data to manage groundfish and prohibited species catch within established limits and to document and reduce fishery interactions with protected species. Much of this information is expeditiously available (e.g., daily or at the end of a trip, depending on the type of vessel) to ensure effective management. Scientists also use fishery-dependent data to assess fish stocks, evaluate marine mammal interactions with fishing gear, characterize fishing impacts on habitat, and provide data for fisheries and ecosystem research and fishing fleet behavior.

The deployment of monitoring assets (observers and/or EM) is the first stage of a hierarchical sampling design (Cahalan and Faunce 2020). Since 2013, the trip has been the preferred sampling unit. Fishing trips made by vessels are either assigned to full and partial coverage. In full coverage, every trip is monitored by 1 or 2 observers. For full coverage trips, vessel owners/operators are responsible for procuring observer services directly through contracting with one of three NMFS-permitted observer service provider companies. For partial coverage trips, vessel owners/operators declare each trip in a NMFS database and if the trip is selected for coverage, a NMFS-contracted observer provider company arranges for coverage. Funding for partial coverage is obtained from an ex-vessel fee on landings from the prior year and is used by NMFS to pay for observer and EM services. In partial coverage, the ADP specifies the way trips are stratified and the rates at which the strata are sampled.

ADP Process and Schedule

On an annual basis, NMFS develops an ADP to explain how observers and EM will be deployed for the upcoming calendar year, and prepares an Annual Report that evaluates the performance of the prior year's ADP implementation. NMFS and the Council created this ADP / Annual Report process to provide flexibility in the deployment of monitoring assets used to gather reliable data for estimation of catch in the groundfish and halibut fisheries off Alaska.

The ADP allows for partial coverage strata definitions, participation requirements, and selection rates to change each year. Strata changes define how trips will be monitored (for example which vessels belong to observer or EM selection pools and the requirements necessary to participate in each) and may be based on factors such as gear type, vessel length, home or landing port, funding, and monitoring goals. Changes in selection rates reflect the allocation strategy used to deploy observers and EM in the partial coverage category.

The flexibility offered by the ADP allows NMFS and the Council to achieve transparency, accountability, and efficiency from the observer program. The ADP process ensures that the best available information is used to evaluate deployment, including scientific review and Council input, to annually determine deployment methods. The observer program is accountable to operate within annual financial constraints that are dependent on the amount of fee revenue collected from groundfish and halibut landings in the prior year and the anticipated future costs of monitoring and fishing effort. The annual decision about how to apportion fees between observer deployment and EM system deployment is a mechanism to achieve cost effective monitoring.

The Annual Report informs the Council and the public about how well various aspects of the program are working. The review highlights areas where improvements are recommended to 1) collect the data necessary to manage the groundfish and halibut fisheries, 2) maintain the scientific goal of unbiased data collection, and 3) accomplish the most effective and efficient use of the funds collected through the observer fees.

The schedule for the ADP / Annual Report process is roughly the same each year, however it differed for the 2023 ADP as described below.

- **June 2022:** NMFS presented the 2021 Annual Report (AFSC/AKR 2022) to the Council and the public. Based on input from the Council, the 2021 annual report differed from previous years and had a less detailed review of the deployment of observers and EM relative to the intended sampling plan. Providing less detail in the annual report enabled analytical staff the time necessary to work on a comprehensive partial coverage cost efficiency analysis for implementation in the 2024 ADP. The cost efficiency analysis and 2024 ADP will consider the myriad changes in monitoring tools available since the restructuring of the partial coverage observer program, including regulated programs for EM; increased use of shoreside observers for biological data collections of unsorted catch; new Limited Access Privilege Program which will move trips from partial coverage to full coverage; and reevaluating criteria to define the ‘zero selection’ pool.

After review of the annual report, the Council provided recommendations on the 2022 ADP that included continued support for the comprehensive partial coverage cost efficiency analysis as well as a recommendation to adopt a 2023 deployment model based on the elements of the 2022 ADP (Appendix A).

- **September – November 2022:**
 - The Council’s Partial Coverage Fisheries Monitoring Committee (PCMFAC) met and received an update on the budget for the 2023 ADP and the Partial Observer Coverage Cost Efficiencies Integrated Analysis.
 - The deadline for trawl catcher vessels in the partial coverage category to request placement into full coverage while fishing in the BSAI was October 15, 2022.
 - The deadline for vessels in the partial coverage category using fixed-gear to request to be in the 2023 EM selection was November 1, 2022.
 - NMFS staff prepared the Final 2023 ADP.
- **December 2022:** NMFS finalizes and releases the 2023 ADP to the public during the Council meeting.

2023 Deployment Methods

Selection Method

For 2023, NMFS will implement trip selection from all ports throughout Alaska as the method of assigning both observers and EM to at-sea fishing events for vessels in the partial observer coverage category. Trip-selection refers to the use of the fishing trip as the primary sampling unit, and is accomplished using the Observer Declare and Deploy System (ODDS; Faunce et al. 2021). In addition to logging each of their trips, vessels in the EM selection pool will also use ODDS to close each trip following the instructions in their Vessel Monitoring Plan (VMP).

The deployment of EM and observers at all ports is consistent with the June 29, 2021 [updated NOAA Fisheries observer waiver policy](#), which states that vessels are no longer eligible for release from observer coverage under the Emergency Rule if a fully vaccinated or quarantined/shelter-in-place observer is available. If no observers are available for deployment, NMFS could release partial coverage trips from observer coverage on a case-by-case basis. This approach is consistent with existing regulatory authority at 50 CFR 679.51(a)(1). The partial coverage observer provider, AIS, Inc., will work with NMFS to release trips when they are unable to provide an observer who is compliant with applicable protective plans. If transportation availability and/or health and travel advisories change, NMFS could modify the deployment approach and restrict deployment to a set of ports with available observers. Any revisions to the deployment of observers due to changes in health and travel advisories would be published through an Alaska Region Information Bulletin.

Selection Pools and Stratification Scheme

Fishing trips are divided into selection pools broadly defined by whether monitoring is required on either all trips or a subset of trips as well as whether the trips will be monitored by observers or EM. Selection pools may be further split into sampling strata, each with a specified monitoring rate. The following selection pools and strata constitute the 2023 ADP:

Full Coverage Pool (Selection rate = 100%)

Vessels and processors in the full observer coverage category must comply with observer coverage requirements at all times when fish are harvested or processed. Specific requirements are defined in regulation at 50 CFR § 679.51(a) (2). The full coverage category includes the following:

- Catcher/processors (with limited exceptions).
- Motherships.
- Catcher vessels participating in programs that have transferable prohibited species catch (PSC) allocations as part of a catch share program.
- Catcher vessels using trawl gear that have requested placement in the full coverage category for all fishing activity in the BSAI for one year.
- Inshore processors receiving or processing Bering Sea pollock.
- Catch share programs with transferable PSC allocations include Bering Sea pollock (both American Fisheries Act and Community Development Quota (CDQ) programs), the groundfish CDQ fisheries (CDQ fisheries other than Pacific halibut and fixed-gear sablefish; only vessels greater than 46 ft LOA), and the Central GOA Rockfish Program.

No-selection pool (selection rate = 0%)

The no-selection pool is composed of vessels that will have no probability of carrying an observer on any trips for the 2023 fishing season. These vessels are:

- fixed-gear vessels less than 40 ft length overall, where length overall is defined in regulations at 50 CFR 679.2 and means the centerline longitudinal distance, rounded to the nearest foot; and
- vessels fishing with jig gear, which includes handline, jig, troll, and dinglebar troll gear.

Observer Trip-Selection Pool

There are three observer trip-selection strata based on gear for 2023. Details on how selection rates were determined are provided in Appendix B.

- Trawl gear (TRW, selection rate = 23%) – This stratum is composed of all trawl trips in the partial coverage category that are not in Trawl EM. The subset of trips that deliver primarily pollock in the GOA will also be subject to dockside monitoring (See Dockside Monitoring Section) at selection rates equal to the at-sea rate in the GOA (deliveries of trawl pollock in the BSAI are in full coverage).
- Hook and line gear (HAL, selection rate = 18%) – This stratum is composed of all vessels in the partial coverage category that are greater than or equal to 40 ft LOA, fishing hook and line gear, and not in Fixed-Gear EM.
- Pot gear (POT, selection rate = 17%) – This stratum is composed of all vessels in the partial coverage category that are greater than or equal to 40 ft LOA, fishing pot gear, and not in Fixed-Gear EM.

Fixed-Gear EM Trip Selection Pool

Any vessel in the fixed-gear EM selection pool in 2022 remained eligible to be in the EM selection pool for 2023 unless a request was submitted to leave the EM selection pool, NMFS has disapproved the vessel's VMP, or if the vessel operator has repeat problems with EM system reliability or video quality or has failed to comply with the requirements in their VMP. All the requests to be in or out of the EM selection pool for 2023 must have been received in ODDS by November 1, 2022.

The fixed-gear EM pool in 2023 will consist of 179 vessels approved by NMFS. This includes 170 vessels that were previously approved by NMFS and 9 new vessels that requested to be added to this pool in 2023.

The fixed-gear EM selection pool consists of two sampling strata:

- EM Hook-and line (EM_HAL, selection rate = 30%)
- EM POT (EM_POT, selection rate = 30%)

Vessel owner/operators receive notification of NMFS approval of their placement in the EM pool by logging into ODDS. Once approved, that vessel will remain in the EM selection pool for the duration of

the calendar year. Each year, all the vessels in the EM selection pool—including those that were previously in the pool—are required to submit and follow an NMFS-approved Vessel Monitoring Plan¹.

As part of the VMP approval, NMFS will assess a vessel's adherence to their approved VMP. For example, does a vessel operator have recurring issues (such as obstructing the camera view or consistently not addressing camera cleanliness) that have resulted in unusable or very poor quality EM data? The quantity and severity of compliance issues that impact the quality and use of that data will be used to assess the standing of a vessel and their eligibility to participate in the fixed gear EM program. NMFS will notify the vessel operator of their status through a cover letter attached to the VMP approval on an annual basis. A vessel with poor standing will be placed into probation status and the vessel owner/operator will be notified of specific issues they need to address in order to bring the vessel into compliance. Failure of a vessel operator to address these issues or comply with other conditions of the VMP may result in the vessel not being eligible to participate in the EM pool in the following year. NMFS expects to remove a sub-set of these vessels from the fixed-gear EM pool in 2023, however the agency's initial determinations are appealable so these vessels remain in the pool for the purposes of the ADP. Vessels which are removed from the fixed-gear EM pool automatically revert to the observer pool.

EM system installation and maintenance will be scheduled in the primary ports of Sitka, Homer, Kodiak, and secondary ports such as Juneau, Petersburg, Sand Point, King Cove, and Dutch Harbor may have periodic EM installation services available. Vessels not available during scheduled dates of EM installation in a secondary port will be required to travel to a primary port for EM installation services prior to the date of their first logged trip in ODDS. Primary and secondary port services apply to EM equipment installation and servicing only, there are no restrictions on where a vessel may make landings associated with this program. Once installed, the EM sensors and cameras will remain on the vessel until either 1) the boat opts out of the EM pool for the following year; or 2) NMFS determines that the vessel will not be eligible to participate in the EM selection pool the following year.

Trawl EM Trip-Selection Pool

NMFS has issued an Exempted Fishing Permit (EFP) to evaluate the efficacy of EM on pollock catcher vessels using pelagic trawl gear in the Bering Sea and Gulf of Alaska². Industry received funding from the National Fish and Wildlife Foundation (NFWF) to support this project. The specific requirements for vessels in the trawl EM trip-selection pool was determined through the permit approval process. NMFS approved the EFP in January, 2020, allowing pollock catcher vessels using pelagic trawl gear to use EM systems in lieu of at sea observers. All trips in this pool are subject to EM with the goal of monitoring for compliance with at-sea maximized retention. In 2023, 79 vessels are expected to participate in the Trawl EM EFP.

The subset of trips that deliver primarily pollock to tenders or shoreside processors will be subject to dockside monitoring to collect genetic samples from salmon bycatch to support work to identify their stock of origin. Selection rates are as follows:

¹ The VMP template is available at: <https://alaskafisheries.noaa.gov/fisheries/electronic-monitoring>

² More details on the EFP permit are available at: <https://www.fisheries.noaa.gov/alaska/resources-fishing/exempted-fishing-permits-alaska>

- BSAI Trawl EM (selection rates = 100% shoreside by observers, 100% at-sea compliance monitoring with EM)
- GOA Trawl EM (selection rates = 33% shoreside by observers, 100% at-sea compliance monitoring with EM). If a vessel opts out of this stratum for a trip, it will enter the observer trip-selection pool as a TRW stratum trip.

Allocation Strategy

Allocation strategy refers to the method of allocating deployment trips among strata. Starting in 2018, NMFS has implemented the observer allocation strategy of 15% threshold plus optimization, where observer sea days are first allocated equally up to a threshold coverage rate and the remaining sea-days are allocated using an algorithm that maximizes precision for chosen metrics (such as halibut PSC) for the least cost. The draft 2022 ADP provided more information on an adjusted approach where the baseline coverage rate ensures a 95% probability of achieving the threshold coverage rate of 15%, after which additional observer days are allocated using an optimization algorithm ('15% + Opt 95'; NMFS 2021).

In 2023, NMFS will implement an observer deployment allocation strategy of an adjusted 15% baseline, plus optimization based on discarded groundfish, Pacific halibut PSC, and Chinook PSC. This method is precautionary with respect to avoiding bias and increasing the chance of getting data across all gear types and areas while still providing the ability for 'extra' monitoring to be distributed based on an optimization plan. The approach provides a balance between minimizing the variability of discard estimates, prioritization of PSC-limited fisheries, and the need to reduce gaps in observer coverage in the partial coverage category.

Dockside Monitoring

Observers will continue to collect genetic samples from salmon caught as bycatch in groundfish fisheries to support efforts to identify stock of origin. Dockside monitoring by observers occurs in the pollock fishery to enable complete enumeration of salmon bycatch and to conduct biological sampling. For trips in the BSAI trawl pollock fishery, both for catcher vessels in the trawl EM pool and those not in trawl EM, a census of salmon will be completed during the offload. Offload monitoring for salmon will also take place for vessels in the trawl EM pool that deliver either a tender and shoreside processor in the GOA. Trips will be randomly selected and offloads will be monitored by observers in shoreside processing facilities.

For vessels that do not participate in the Trawl EM EFP and deliver to shoreside processors in the GOA pollock fishery, trips that are randomly selected for at-sea observer coverage will be completely monitored for Chinook salmon bycatch by the vessel observer during offload of the catch at the shoreside processing facility. For trips in the GOA pollock fishery (outside of the EFP) that are delivered to tender vessels and trips outside of the pollock fishery, salmon counts and tissue samples will be obtained from salmon found within observer at-sea samples of the total catch.

If COVID-19 protocols at shoreside processing plants prevent vessel observers from entering the processor to complete any further sampling, NMFS may alter data collection procedures to accommodate safety protocols. This would follow the methods developed in 2020, where shore-based observers completed the sampling for pollock trawl vessels regardless of whether the vessel was observed at-sea or if it participated in the trawl EM EFP.

Observer Declare and Deploy System (ODDS)

Owners or operators of vessels making trips in the observer pool must log anticipated trips into ODDS prior to sailing. Owners or operators of vessels making trips in the EM selection pool must log anticipated trips into ODDS prior to sailing and must also use ODDS to close each trip following the instructions in their Vessel Monitoring Plan (VMP). NMFS creates user accounts for new partial coverage trip-selection participants so that they may access the application at <http://odds.afsc.noaa.gov/> and log planned fishing trips electronically. Only trips not selected for monitoring can be changed or closed by using ODDS, for selected trips those actions must be completed by calling the ODDS call center (1-855-747-6377).

For 2023, the user experience in ODDS will not change for a vessel operator. Communication between users and NMFS is facilitated through odds.help@noaa.gov. NMFS will retain the current business operating procedure of allowing vessels to log up to three trips in advance and programming that waives observer coverage when a third consecutive observer trip is selected in the Hook and Line and Pot strata.

Selection Rates

Table 1 lists the selection rates that will be in place for vessels in the partial coverage category for deployment of observers (50 CFR 679.51(a)) and electronic monitoring ((50 CFR 679.51(f)) in 2023. In 2023, NMFS expects to monitor for catch accounting 2,520 trips in full coverage and 1,090 trips in partial coverage.

Table 1. Summary of total trips, allocation weights, selection rates, and the number of trips expected to be observed in each -sampling stratum in 2023.

Component	Pool	Stratum	Total Number of Expected Trips	Allocation Weight	Selection Rate (%)	Number of Trips Expected to be Observed
Partial Coverage	Observer Trip Selection	Hook-and-line	1,253	0.31	17.87	224
		Pot	1,163	0.07	17.09	199
		Trawl	805	0.63	22.68	183
	Total		3,221	1.00	18.79	606
	Fixed-Gear EM trip selection	EM Hook-and-line	669		30.00	201
		EM Pot	408		30.00	122
Total		1,077		30.00	323	
Trawl EM Trip Selection	Trawl EM (GOA)		482		33.33*	161
		Total	482		33.33	161

	No selection	Hook-and-line	1,514	0.00	0
		Pot	45	0.00	0
		Total	1,559	0.00	0
Full Coverage	Full	Observer	1,576	100.00	1,576
	Trawl EM	Trawl EM (BSAI)	944	100.00	944
		Total	2,520	100.00	2,520

*Trawl EM has 100% compliance monitoring at-sea with video and 33% of offloads are sampled by observers at the shoreside processing plant.

EM Development Projects

In addition to ongoing pre-implementation of trawl EM, NMFS supports ongoing innovation of EM and collaborating with industry partners on EM development projects, when funding is available. Industry members frequently apply for funding through non-governmental organizations to support these projects, and NMFS is committed to collaborating to the extent possible when funding decisions are announced. Known EM projects for 2023 include:

Test Trawl EM systems on Fixed-Gear Vessels

Aleutians East Borough has received funding from the NFWF for a project to test EM configurations on vessels that fish using multiple gear types. The project would also evaluate catch handling and EM data review protocols for pot vessels in the fixed gear EM program. Volunteer vessels will take observers to provide a proof-of-concept and allow a side-by-side comparison of observer vs. EM counts of bycatch. The project will involve vessels that are already part of the trawl EM EFP and industry partners would work with NMFS to develop appropriate EM system set up and configurations and appropriate VMP requirements.

Annual Coverage Category Requests

Partial coverage catcher/processors

Under Observer Program regulations at 50 CFR 679.51(a)(3), the owner of a non-trawl catcher/processor can request to be in the partial observer coverage category, on an annual basis, if the vessel processed less than 79,000 lb (35.8 mt) of groundfish on an average weekly basis in a particular prior year. The deadline to request placement in the partial observer coverage category for the following fishing year is July 1 and the request is accomplished by submitting a form³ to NMFS. Three catcher/processors requested, and NMFS approved their placement in the partial coverage category for the 2023 fishing year.

Full coverage catcher vessels

Under Observer Program regulations at 50 CFR 679.51(a)(4), the owner of a trawl catcher vessel may annually request the catcher vessel to be placed in the full observer coverage category for all directed fishing for groundfish using trawl gear in the BSAI management area for the upcoming year. Requests to be placed into the full observer coverage in lieu of partial observer coverage category must be made

³ The form for small catcher/processors to request to be in partial coverage is available at: <https://www.fisheries.noaa.gov/webdam/download/85047638>

in ODDS⁴ prior to October 15, 2022 for the 2023 fishing year. Each year, the list of catcher vessels that have been approved to be in the full coverage category is available on the NMFS website⁵.

Vessels Participating in Halibut Deck Sorting

On October 24, 2019, NMFS published a final rule to implement regulations allowing halibut to be sorted on deck of trawl catcher/processors in the non-pollock fisheries off Alaska. Fishing under the new regulations began on January 20, 2020. The final rule implementing this program does not specify the amount of time allowed for vessel crew to sort, and observers to discard, deck-sorted halibut. This flexibility enables NMFS to adjust sorting times in response to new information. In 2023, NMFS will continue to allow all vessels operating under these regulations 35 minutes to deck-sort and discard halibut. This uniform time allowance maintains the protocol from previous years and is consistent with the fact that there is no data to support vessel-specific deviations from the current time limit.

Voluntary Increase in Observer Coverage on Freezer Longline Vessels

In order to increase the number of non-trawl lead level 2 (LL2) endorsed observers, the Freezer Longline Coalition (FLC) and Alaskan Observers (AOI) are intending to deploy two observers on select catcher/processor longliners. This unique approach combines the two monitoring options in [50 CFR 679.51\(a\)\(2\)\(vi\)\(E\)](#) and [§ 679.100\(b\)](#) by taking increased observer coverage and using a flow scale.

Combining the monitoring options provides increased opportunities for observers to gain a non-trawl LL2 endorsement, supports the collection of high quality data by increasing sampling on these select vessels and sharing the sampling workload, and uses a flow scale to determine the weight of all retained Pacific cod. Additionally, deploying two observers to a challenging sampling platform has the potential to increase observer retention by improving the inexperienced observer's experience through mentorship and minimizing burn-out for the experienced observer.

Communication and Outreach

NMFS will continue to communicate the details of the ADP to affected participants through letters, public meetings, and information on the internet:

- Information about the Observer Program and Frequently Asked Questions Observer deployment are available at <https://www.fisheries.noaa.gov/alaska/fisheries-observers/north-pacific-observer-vessel-plant-operator-faq>
- Frequently asked Questions about EM are available at: <https://www.fisheries.noaa.gov/alaska/resources-fishing/frequent-questions-electronic-monitoring-em-small-fixed-gear-vessels>
- For technical information and Frequently Asked Questions regarding ODDS go to <http://odds.afsc.noaa.gov/> and click the “ODDS login” button.

⁴ Instructions for catcher vessels to request to be in full coverage using ODDS are available at: <https://www.fisheries.noaa.gov/resource/document/bsai-trawl-catcher-vessel-annual-full-observer-coverage-request>

⁵ List of BSAI trawl catcher vessels in full coverage available at <https://www.fisheries.noaa.gov/resource/document/bsai-trawl-catcher-vessels-cvs-full-coverage>

Observer Program staff are available for outreach meetings upon request by teleconference and/or video conferencing pending staff availability and local interest. A community partner would be needed to organize a location and any necessary equipment to facilitate additional meetings. To request a meeting or suggest a topic for discussion, please contact Jennifer Ferdinand at 1-206-526-4076 or Jennifer.Ferdinand@noaa.gov.

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List of Preparers and Contributors

ADP Analysis Team:

- Craig Faunce, Alaska Fisheries Science Center (AFSC)
- Phil Ganz, Alaska Regional Office (AKRO)
- Geoff Mayhew, Pacific States Marine Fisheries Commission (PSMFC)

Other contributions from:

- Maggie Chan, AKRO
- Cathy Tide, AKRO
- Jennifer Ferdinand, AFSC
- Jennifer Mondragon, AKRO
- Mike Vechter, AFSC

Appendix A. Council motions related to Annual Report and ADP

Council motion

D-5 Partial Coverage Fisheries Monitoring Advisory Committee (PCFMAC)

October 10, 2022

The Council recommends the analytical staff provide further description and evaluation of the proposed deployment designs, evaluation criteria, and underlying assumptions for the partial coverage cost efficiencies analysis as outlined in the September 2022 PCFMAC report. The Council supports an abbreviated 2022 Observer Annual Report (Chapters 3 and 4) to meet these requests and complete the cost efficiencies analysis in time for incorporation in the draft 2024 observer annual deployment plan.

Council motion

Observer Program Annual Report

June 11, 2022

Observer Program 2021 Annual Report

The Council appreciates the 2021 Annual Report on the observer program and recommends NMFS update the total 2021 fixed gear electronic monitoring (EM) seadays reviewed by PSMFC and costs for the final report.

2023 Annual Deployment Plan (ADP)

The Council supports maintaining the stratification and allocation strategy from the 2022 ADP in 2023. The Council also supports 1) additional fixed gear EM vessels (30% coverage) in the EM pool in 2023 (up to 200 total vessels) provided they opt-in prior to November 1, 2022, additional funding for EM equipment is secured, and they meet the criteria in the ADP; and 2) continuation of the pelagic trawl EM project with 100% at-sea monitoring in addition to shoreside observer coverage.

Cost Efficiencies Analysis

The Council continues to strongly support NMFS' work on the comprehensive partial coverage cost efficiencies analysis to support cost savings and higher coverage rates under a schedule which allows:

- Implementation in the 2024 ADP
- Results to inform the next federal observer contract
- The PCFMAC to convene to review the draft sampling elements (likely early fall)
- The PCFMAC to convene prior to the analytical team incorporating elements into a sampling design (likely early 2023)

The Council does not support evaluation of port-based deployment that requires vessels to travel to select ports to pick up an observer in the cost efficiencies analysis.

Appendix B. Calculation of the Selection Rates for the partial coverage strata of the 2023 ADP

Introduction

The Annual Deployment Plan (ADP) specifies how fishery monitoring assets (observers and Electronic monitoring equipment - EM) are deployed into fishing operations of the North Pacific by the North Pacific Observer Program (Observer Program) of the Alaska Fisheries Science Center, National Marine Fisheries Service (NMFS). The ADP is focused on fishing operations for which sampling rates will be less than 100% (i.e., the partial-coverage fleet). The partial coverage fleet consists of catcher vessels and some catcher processors when not participating in a catch sharing or cooperative style management program. Changes to the composition of the partial coverage fleet have resulted from NMFS policy, Council actions, and regulations.

The sampling design hierarchy used to obtain fishery dependent data has several levels, and the ADP is important since it affects the first, and top-most level of this hierarchy (Cahalan and Faunce 2020). The sampling design for the deployment of fishery monitoring assets (i.e. the deployment design) involves two elements; how the population of partial coverage trips is subdivided (*stratification*), and what proportion of the total observer deployments are to occur within these subdivisions (*allocation*).

The ADP process includes a draft and final version. The draft ADP is focused on presenting alternative deployment designs for consideration for the year ahead, while the final ADP is focused on predicting the most likely coverage rate that available budgets can afford given the selected design from the draft ADP. In this way, the ADP provides an annual process for the NMFS and the North Pacific Fisheries Management Council (Council) to evaluate and recommend improvements to fisheries monitoring in response to changing needs.

An exception to the ADP process occurred in 2023. At their June 2022 meeting, the Council approved a NMFS recommendation to roll forward the major elements of the final 2022 ADP into 2023 in order to enable staff to work on the integrated cost efficiencies analysis. Therefore, in 2023 a draft ADP was not performed.

Since the inception of the ADP process in 2012 (2013 ADP), trip-selection has been the preferred method to deploy fishery monitoring assets into the partial-coverage fleet.

The 2023 Sampling Design

Following NMFS recommendation and the Councils' support (Appendix A), the selection pools, sampling strata and allocation methods for this 2023 ADP follow the draft 2022 ADP. Selection rates for fixed-gear EM strata were set at 30% based on NMFS policy and Council working group input. The sample allocation strategy for observer-monitored strata follows the '15% + Opt 95' method. In this method, each stratum is allocated a number of sample days required to achieve a 95% probability that at least 15% of trips will be observed (the baseline), and then additional monitored trips are allocated through a blended optimal allocation algorithm. This blended optimal algorithm, which has been in use since 2016, equally weights three optimal allocations among strata that each consider trip cost and variance in either discarded groundfish, Pacific halibut PSC, or Chinook salmon PSC. Optimal allocations are only applied if the baseline can be achieved. Following the methods used since 2018, if the baseline cannot be achieved, all observer-based strata receive the same selection rate.

Methods

The methods in this section largely follow those used in the draft 2022 ADP (NMFS 2021). They are visually depicted in Figure B-1.

Data Preparation: Defining the partial coverage fleet

A dedicated dataset developed by the staff of the Sustainable Fisheries Division of the Alaska Regional Office (AKRO) and the Fisheries Monitoring Division (FMA) of the Alaska Fisheries Science Center was used in this analysis. Briefly, these data consist of species-specific catch amounts, fishing dates, locations, catch disposition, observation status, and associated ADP strata from 1 January 2013 to 10 October, 2022.

As in past ADPs, trip data were altered to reflect fishing effort in the partial coverage fleet for the upcoming year. These alterations included: (1) using ODDS data to more accurately model the duration that observers are assigned to selected fishing trips (NMFS 2019, Appendix C), (2) labeling fishing activity by four ‘historical low volume’ Catcher-Processors as belonging to the partial coverage category, (3) labeling fishing by American Fisheries Act (AFA) eligible trawl vessels targeting Pacific cod in the Bering Sea Aleutian Islands Fisheries Management Plan Area (BSAI) as belonging to the full coverage fleet if they indicated this was their preferred coverage for this activity in 2023, and (4) removing vessels with no probability of selection from the analysis (i.e., all trips corresponding to the zero selection pool). Vessel lists for the Fixed Gear EM pool and Trawl EM pool were updated following information provided by industry (Trawl EM) and approval processes by the FMA Division through ODDS after Nov. 1⁶ respectively (vessels using Hook and Line or Pot Gear with EM). A full description of the selection pools and stratum are provided in Table B-1.

The 2023 sampling design includes the following strata, which are defined by gear and monitoring method (observers or EM):

1. **HAL_EM**: EM of trips using hook-and-line gear on vessels that are greater than or equal to 40 ft. LOA and have been approved to carry EM.
2. **POT_EM**: EM of trips using pot gear on vessels that are greater than or equal to 40 ft. LOA and have been approved to carry EM.
3. **TRW_EM**: Compliance monitoring of trips by vessels participating in the Pollock Trawl EM EFP in the Gulf of Alaska and shoreside monitoring of a subset of offloads.
4. **HAL**: Observer monitoring of trips using hook-and-line gear on vessels that are greater than or equal to 40 ft LOA and are not in HAL_EM.
5. **POT**: Observer monitoring of trips using pot gear on vessels that are greater than or equal to 40 ft LOA and are not in POT_EM.
6. **TRW**: Observer monitoring of trips by vessels using trawl gear, excluding trips where vessels are participating in the Pollock Trawl EM EFP.

Budget Forecasting

Partial coverage observer deployment is paid for according to a contract between NMFS and its partial coverage observer provider. Under this contract there are guaranteed days that carry a high ‘front-load’

⁶ The rules governing fixed-gear EM participation are specified in regulations published in 2017. Participation in EM is voluntary. Between September 1 and November 1 of each year, vessels can request to participate in EM through ODDS. After November 1, NMFS approves or denies EM requests based on vessel eligibility and the available funding.

cost that includes much of the risk / reward incurred by the provider. Above and beyond this number of guaranteed days there are option days. Option days are less expensive to NMFS on a per unit basis. In this way, when measured in terms of total costs per day, economic efficiency is correlated with budget size - the larger the budget, the less deployment costs per unit. This ADP uses contract day costs for observer coverage and a ratio estimator of actual travel to contract day costs to generate models of total costs for a given number of contracted days for future years. Using inputs of the available budget, past expenditures, and estimated revenue from fee proceeds, an initial budget can be set so that the observer program can be sustained for a predetermined period of time. This method ensures the most up-to-date cost information is used while balancing the needs for a stable fishery monitoring program.

In this analysis a budget was set to support equally-sized annual sea day budgets for 2023 through 2025 while also sustaining \$1M for fixed-gear EM every year (Table B-2). In addition, an annual estimate of \$210,000 was budgeted to cover anticipated costs of a regulated dockside Trawl EM program in 2024 and 2025 in expectation that the program would be regulated and EFP funds could no longer be used for this activity.

Accounting for uncertainties

The uncertainties inherent in this analysis include how fishing activity will change from the past to 2023, and how coverage rates need to be set in order to keep the fishery monitoring program fiscally solvent. Accounting for these uncertainties was accomplished through simulation described in more detail in the following sections.

Predicting future fishing effort

Predicting future fishing effort is simplified by assuming the future is most similar to the prior year. However, when this analysis is conducted only a partial year of 2022 is available. For this analysis, data for 2022 were available through 10 October. Future fishing effort for the upcoming year was predicted by projecting the end of 2022 fishing effort and assuming that would equal 2023 fishing effort. The projection largely follows the methods detailed in Ganz and Faunce (2019). Briefly, trends in cumulative effort from 2019-2022 inclusive were examined by stratum, Fishery Management Plan (FMP) area (GOA or BSAI), and target species (halibut, Pacific cod, pollock, sablefish, or "other"), and a set of years similar to 2022 were selected for projection. The ratios of total effort over effort-to-date from previous similar years were applied to the effort-to-date in 2022 for each stratum, FMP, and target species combination. In this analysis the average ratio among years was used for fisheries that showed a consistent effort trajectory among past years. For many of the Pacific cod fisheries in the GOA, only the ratio from 2021 was used because it was the most recent full year of data and because directed fishing for GOA Pacific cod in federal waters was closed in 2020. A ratio of 1 was applied in cases where 2022 effort-to-date was considered finished by 10 October 2022.

Uncertainty in fishing effort

A source population of trips for simulation was created by appending fishing effort during 11 October - 31 December 2021 to fishing effort during 1 January - 10 October 2022. Simulated fishing populations for 2023 were then generated by sampling with replacement the source population of trips until the number of fishing trips in each stratum, FMP area, and target species was equal to the number of fishing trips predicted. To account for uncertainty in the predicted number of fishing trips for 2023, the total predicted number of fishing trips was adjusted for each simulation by adding a random value sampled from a normal distribution that represented up to $\pm 4.83\%$ of the original prediction (the average absolute percentage that estimates have differed from realized effort since 2019, when the current effort prediction methodology was first implemented). This process was repeated 1,000 times to create 1,000

versions of the 2023 fishing effort (*2023 simulated populations*), each with its own unique trip duration distribution.

Uncertainty due to Pollock trawl EFP

The Pollock Trawl EM EFP includes a provision where a vessel fishing in the Gulf of Alaska (GOA) may opt out of the EFP (and thus opt into random selection for at-sea observer coverage) on a trip-by-trip basis. For Pollock Trawl EM EFP vessels in partial coverage, simulated future fishing trips were given a 76.10% probability of being under the EFP by random draw based on past participation in the EFP (2021 - 2022) on a trip by trip basis.

Determining selection rates for 2023

The selection rate that can be afforded in the coming year depends on several factors, chiefly the amount of fishing that is expected to occur, the available budget, and estimated monitoring costs. It is important to note that while the 2023 partial coverage fishing effort was predicted by stratum, FMP area, and target species, observers are only deployed by stratum. The optimal sample allocation weightings for each stratum were calculated using an updated 2019 - 2022 data set by following the methods detailed in the draft 2022 ADP for the preferred design (NMFS 2021).

Uncertainty in trip-selection

One problem that arises in simulating future fishery monitoring is the need to account for variation in which trips are selected for monitoring. If only short trips are selected, more trips may be afforded by the same amount of money (and hence a higher selection rate) than if longer trips were selected. As in past ADPs, the analysis of potential selection rates was conducted through iterative stratified random sampling without replacement. For each 2023 simulated population, each trip was assigned a random number between 0 and 1 and ODDS selection processes were simulated. This random number assignment and ODDS simulation was repeated 1,000 times for each of the 1,000 2023 simulated populations to incorporate differences in ODDS selections and selected trip durations. A total of 1,000,000 outcomes result.

Uncertainty in monitoring costs

The total cost of the observer-based fishery monitoring program was calculated using the cost of an observer day and the distribution of trip durations from each of the 1M outcomes. Cost per day was estimated in order to most closely match expense rates specified by the partial-coverage contract. The partial coverage observer contract is currently in its final option year, so the costs of observer days in future years was estimated assuming an annual inflation rate of 3%. Estimates of cost per day took into account whether the day was a guaranteed day (up to 2,000 days) or an optional day, and estimated travel costs from a linear model using monthly days purchased against travel cost invoices. Total expenditures in simulated fishery monitoring deployments for 2023 were set so that there was an equal chance of being over or under budget. The steps taken to calculate selection rates are depicted as a diagram in Figure B-1.

Results and Discussion

Table B-2 shows the available budgets and expected vessel participation for the partial coverage fleet in 2023. The available budgets for partial coverage at-sea observer deployment and Fixed Gear EM were set at \$4,896,623 and \$1,000,000, respectively. The fixed-gear EM pool consisted of 179 vessels approved by NMFS. Nine vessels requested to be added to the fixed-gear EM pool and NMFS approved all requests. There will be no vessels participating in Fixed Gear EM Research in 2023. A list of 79

vessels expected to participate in Trawl EM EFP was received on 2 November 2022. Expected vessel participation for the other fishery monitoring strata is provided in Table B-2.

The coverage rates expected to be afforded in 2023 are shown in Table B-3. Coverage rates among all strata are sufficient to meet the adjusted hurdle and include additional optimized allocation among all sampled populations (Figure B-2).

The expected difference between the available budget and the expended cost is depicted as a risk-profile in Figure B-3. The 95% confidence interval ranges between \$311,681 under budget (-6.4%) and \$320,707 over budget (+6.5%).

Literature Cited

Cahalan, J. and C. Faunce. 2020. Development and implementation of a fully randomized sampling design for a fishery monitoring program. U.S. Fishery Bulletin 118:87-99.

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Table B-1. Description of deployment pools and strata for fisheries monitoring of the partial coverage fleet in 2023. NFWF = National Fish and Wildlife Foundation.

Pool (Stratum)	Applies to	At-Sea				Dockside			
		Monitor	Purpose	Selection Rate	Funding Source	Monitor	Purpose	Selection Rate	Funding Source
Fixed Gear EM (HAL_EM, POT_EM)	Fixed Gear Vessels that volunteer to participate in EM for catch estimation and are approved by NMFS.	EM	Catch estimation	30%	NFWF / industry fees / Federal funds	None	NA	0%	NA
Trawl EM (TRW_EM)	Vessels fishing pelagic trawl gear in the pollock fishery identified in an exempted fishing permit (EFP)	EM	Full retention compliance	100%	NFWF	Observers	Catch & PSC estimation /biological sampling	33%	NFWF
Observer Trip Selection (HAL, POT, TRW)	Longline, Pot vessels >= 40'; and Trawl vessels not participating in the trawl EM EFP	Observers	Catch estimation	Rates afforded according to baseline + optimization	Industry fees	None	NA	0%	NA
No Selection	Jig Vessels, vessels < 40'	None	Economic efficiency & logistics (eg lack of bunk space)	0%	None	None	NA	0%	None

Table B- 2. Budgets and vessel participation in this analysis. Funding is listed for sectors that are funded through the observer fee and NMFS funds. The number of vessels participating is estimated as the number of unique vessels that fished within each stratum within 365 days prior to the completion of the analyses. Some vessels may fish in multiple strata (e.g., a vessel may fish within both EM POT and EM HAL, or a trawl vessel may fish within the Observer pool and Pollock Trawl EM EFP pools).

Final 2023 ADP	
Total anticipated funding (\$)	
At-sea Observer	4,896,623
Fixed-gear EM	1,000,000
Total	5,896,623
Vessels participating (partial coverage)	
At-sea Observer Hook-and-line	296
At-sea Observer Pot	162
At-sea Observer Trawl	77
EM Hook-and-line	126
EM Pot	58
EM Trawl	38
Pollock trawl EM EFP	43
Zero coverage Hook-and-line	312
Zero coverage Pot	6

Table B- 3. Comparison of the predicted number of trips in a stratum (N_h), the optimal sample weighting (W_{hopt}), predicted number of observed or monitored trips (n_h), observed or monitored days (d_h), and coverage rates (r_h) resulting from the deployment sampling design described in the text for 2023. Values are medians (50th percentile) from simulated populations.

Pool	Stratum (h)	N_h	W_{hopt}	n_h	d_h	r_h (%)
Observer Trip Selection	Hook-and-line	1,253	0.31	224	1,213	17.87
	Pot	1,163	0.07	199	1,260	17.09
	Trawl	805	0.63	183	621	22.68
	Total	3,221	1.00	606	3,094	18.79
Fixed Gear EM	EM Hook-and-line	669	-	201	1,040	30.00
	Pot	408	-	122	735	30.00
	Total	1,077	-	323	1,775	30.00
Trawl EM	Pollock trawl EM EFP (GOA)	482	-	161	486	33.33
	Total	482	-	161	486	33.33
Zero	Hook-and-line	1,514	-	0	0	0.00
	Pot	45	-	0	0	0.00
	Total	1,559	-	0	0	0.00
Full	Full	1,576	-	1,576	11,530	100.00
	Pollock trawl EM EFP (BSAI)	944	-	944	3,056	100.00
	Total	2,520	-	2,536	14,586	100.00

Figure B- 1. Process diagram for the analyses contained in this appendix. Green boxes indicate inputs and blue boxes indicate iterative and random processes.

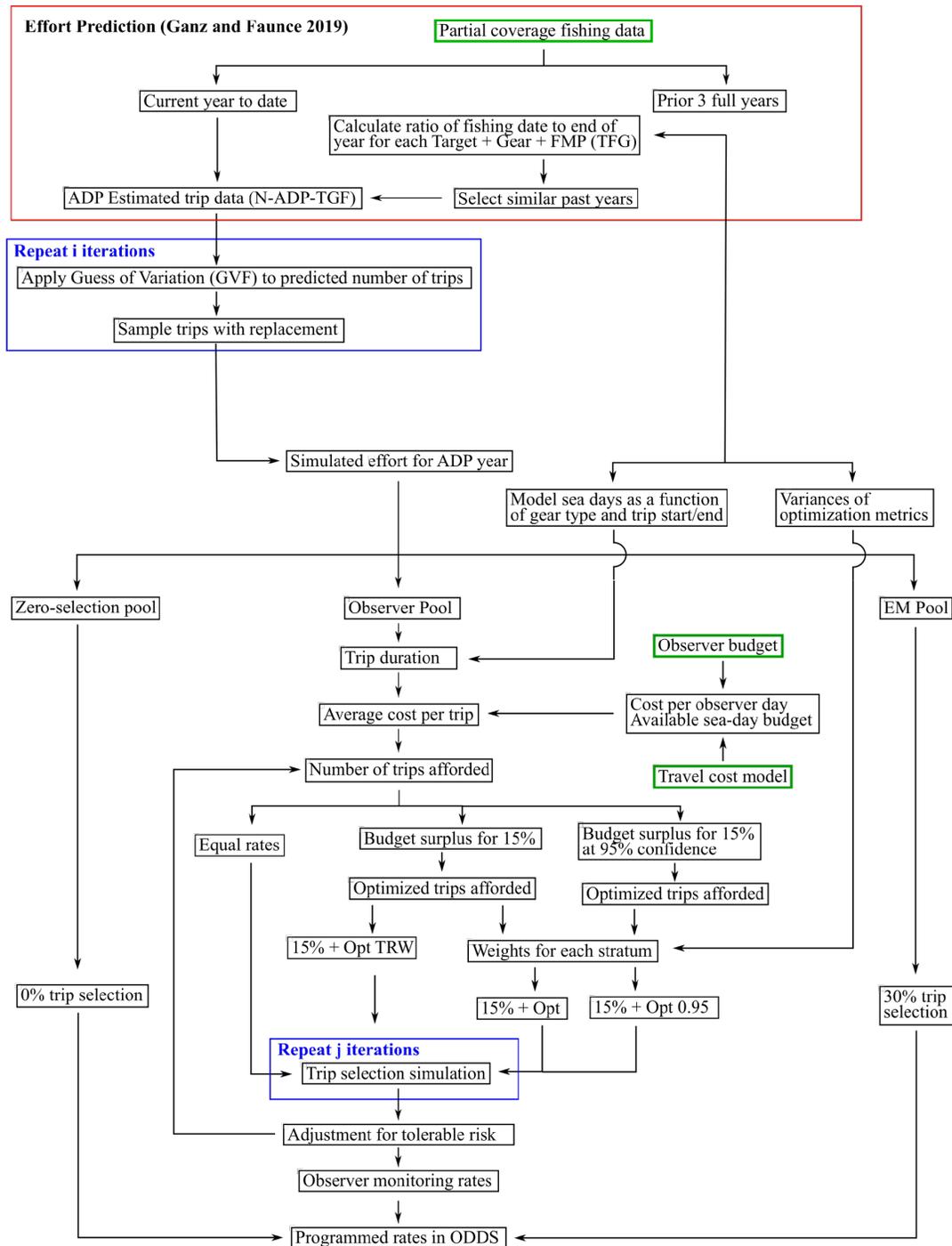


Figure B- 2. Afforded strata-specific rates of at-sea observer coverage for 2023. Individual points within the distributions are the mean selection rates from 1,000 ODDS simulations performed on 1,000 populations (1,000 data points are depicted per stratum although there were 1M outcomes). The 15% selection rate is depicted by the dashed black line. The means from all populations are denoted as cyan 'X's, the medians from all populations are denoted as red horizontal lines, and the distribution of the points is represented by red ovals (the wider the oval the more outcomes had that value).

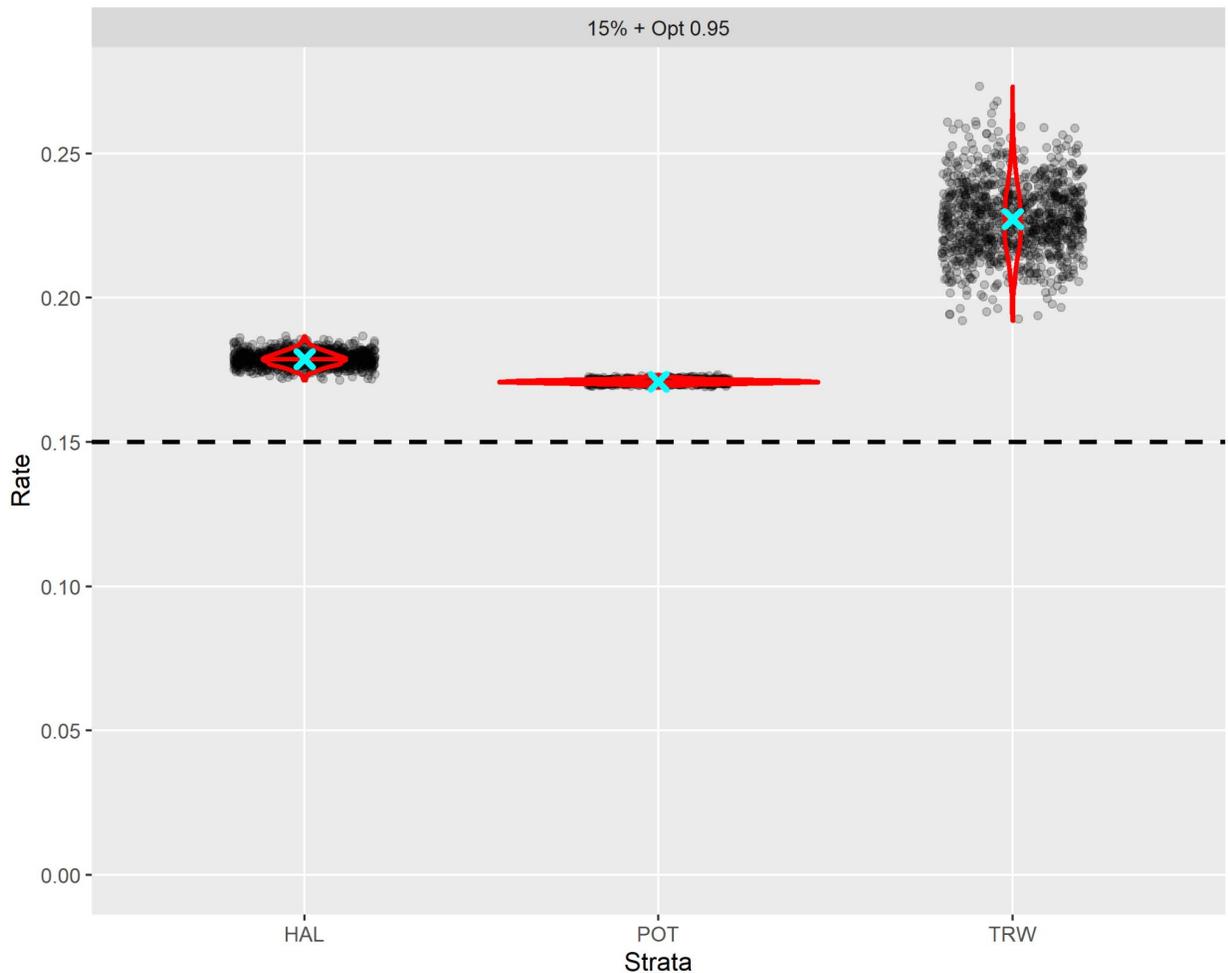


Figure B- 3. Summary of 1,00,000 outcomes of simulated sampling showing the total cost of the program expected for 2023. Vertical lines depict the available budget (dashed purple line), median expected cost (dashed blue line), and 95% confidence limits (dashed red lines).

